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Performance Evaluation and Optimization to support Quality of Service schemes in Optical Burst-Switched Networks

By

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Introduction:

Today's upsurge growth of internet requires huge bandwidth for accessing and downloading comprehensive applications such as audio, video-on-demand, video conferencing, online trading and other multimedia applications. This enthused for the search of substitutes to traditional networks. Wavelength division multiplexing (WDM) is one such technology developed to handle the huge bandwidth demands. WDM is proposed as a transmission technology, which is able to make full use of the huge fiber bandwidth resources to increase the transmission capacity [1]. Optical network supports huge bandwidth and provides transmission of data at a faster rate than the conventional networks. Optical burst switching (OBS) has been proposed as a realistic OPS (optical packet switching) technique to exploit the terabit bandwidth of wavelength-division multiplexing (WDM) transmission technology [2].

Optical burst switching (OBS) is a promising switching paradigm which aspires to provide a flexible infrastructure for carrying future Internet traffic in an effective yet practical manner. The optical burst switching paradigm has attracted considerable interest as an optical networking architecture for efficient support of IP packet traffic and flexible access to the immense transmission capacity available with optical fibers and the Wavelength Division Multiplexing (WDM) technology. OBS provides a compromise between technological requirements and bandwidth utilization efficiency [3].

OBS separates the control and data plane functions in the network .It exploits the distinct advantages of optical and electronic technologies [4]. Signaling messages are processed electronically at every node in the network, while bursts are transmitted transparently end-to-end. So there are chances of burst collision. Burst collision occurs when two or more bursts access the same wavelength simultaneously, and the occurrence becomes more frequent as the offered load increases. In particular, when the network is overloaded, no contention resolution scheme would effectively avoid the collision without the help of congestion control. The rapid growth of large bandwidth multimedia application development resulted in the search for alternative solution to transport these applications. Burst contention occurs when flows from different input lines are sent to the same output port on the same fiber channel (wavelength) at the same time.

In pure OBS, there is no buffer in the core network. Therefore, it is necessary to find way to avoid burst contention and find a scheduling strategy in order to reduce burst loss and increase the overall network performance providing a better QoS (Quality of service).

Literature survey:

From the survey, switching techniques are broadly classified as optical circuit switching (OCS), optical packet switching (OPS), and optical burst switching (OBS). There are some advantages and disadvantages of these techniques. OCS is a connection oriented switching technique in which a connection is set up before actual data transmission on a pre-defined light path from the source to the destination. Large connection set up time and low bandwidth utilization in case of

low traffic load are the major limitations of the OCS. In OPS, a packet comprises data and a header which are in the optical domain. When the packet comes at the core node, the header is extracted from the packet and is converted into the electrical domain for processing. The data in the packet has to be buffered in the core node during header processing. Fiber delay lines (FDLs) are used for this purpose which can provide limited buffering by routing a light to the specific ring of optical fibers. After header processing, the header is converted into the optical domain and is merged with the data again. In the end, the packet is forwarded to the output port which was configured during the header processing. The packet is dropped if the switch is not configured within this time. The major drawbacks of OPS are lack of feasible optical buffers and packet losses due to output port contentions [5].

The OBS network consists of edge and core nodes. Packets arriving from a legacy network (e.g. IP, ATM) at the edge nodes are aggregated into large optical bursts. A control packet is then transmitted on a separate control channel to request resource allocation in all intermediate nodes from the source to the destination edge nodes, so that the assembled burst can pass through unobstructed without any O-E-O conversion. The burst is sent at a particular time after sending the control packet which is called the offset time. During this time, the burst is temporarily stored at the edge node and the switch controllers at the intermediate node process the control packet and set up the switching fabric for the incoming burst[6]-[12].

In OBS the ingress node is responsible for burst assembly, routing, wavelength assignment, scheduling of burst at edge node. The core node is responsible for signaling, scheduling, resolving contention.so the key issues for OBS to improve the QoS are scheduling, avoid burst losses, congestion. In [13], discusses the burst contention resolution problems in optical burst witching (OBS) networks from the viewpoint of network utility maximization. No contention resolution scheme would effectively avoid the collision without the help of congestion control when the network is overloaded. Burst contention resolution and congestion control interact using a distributed algorithm. The algorithm achieves zero burst loss and high throughput at steady state, and outperforms the conventional burst contention resolution schemes.

Most generally used burst assembly schemes are threshold based and timer-based. In a timer based scheme, a timer is started at the initialization of burst assembly. But a large time-out value results in a large packet and higher buffering delay at the edge node .In a threshold-based scheme, a burst is created and sent into the OBS network when the total size of the packets in the queue reaches a threshold value. But the disadvantage of the threshold-based scheme is that it does not provide any guarantee on the assembly delay that packets will experience. The choice of burst assembly algorithms depends on the type of traffic being transmitted [14-15].

There are wavelength reservations schemes which refer to when and how the bandwidth is reserved and release. The reservation schemes in OBS network is adopted from ATM Block Transfer (ABT) [16]. There are two versions of ABT: ABT with delayed transmission and ABT with immediate transmission. These two techniques have been adopted in OBS. Depending on bandwidth reservation, offset time and control management, three schemes for OBS implementation have been proposed: Tell-and-go (TAG) [17], Just-in-time (JIT) [18,19] and Just-enough-time (JET) [20].

There are various wavelength channels scheduling algorithm used to determine a wavelength channel on an outgoing link for the corresponding data burst. The information required by the scheduler such as the expected arrival time of the data burst and its duration are obtained from the control packet. The scheduler keeps track of the availability of time slots on every wavelength channel. It selects one among several idle channels. The selection of wavelength channel needs to be done in an efficient way so as to reduce the burst loss. Scheduling strategy used scheduling algorithms can be classified as Horizon or without void filling [21], with void filling [22].

Optical burst switching is the new switching paradigm for the next generation optical network. In OBS control packets are decoupled from the data packets and are sent in different channels. Control information is sent on control channel and data packets are sent on data channels. Some of the research issues identified in OBS network are burst assembly and disassembly, burst scheduling, contention resolution, survivability for Quality of Service

Motivation:

Life in our increasingly information-dependent society requires that we have access to information at our finger tips when we need it, where we need it, and in whatever format we need it. The information is provided to us through our global mesh of communication networks, whose current implementations unfortunately, don't have the capacity to support the foreseeable bandwidth demands. Optical fiber technology can meet our above need because of its potentially limitless capabilities like huge bandwidth and wavelength division multiplexing (WDM) have resulted in a huge amount of capacity available for transmission over optical links.

The amount of raw bandwidth available on fiber optic links has increased dramatically with advances in wavelength division multiplexing (WDM). In order to efficiently utilize this bandwidth, an all-optical transport method, which avoids optical buffering while handling burst traffic and which supports fast resource provisioning and asynchronous transmission of variable sized packets, must be developed. Optical Burst Switching (OBS) is one such method for transporting traffic directly over a buffer less optical WDM network. A major concern in optical burst switched networks is contention, scheduling, survivability, etc. which are coherent characteristics to provide end to end transmission in optical networks. Internet traffic is increasing immensely due to facility of broadband internet access and emergence of new end user applications. Huge network bandwidth is required due to the remarkable upsurge in the usage of various multimedia applications. In order to fulfill increasing bandwidth demands, internet access providers are continuously enhancing their capacity and capability. Hence optical network is considered as the optimal choice for the next generation high speed network due to potentials and benefits of optical components to provide good QoS

Objective:

In order to improve and make effective utilization of bandwidth in WDM for OBS the objectives are summarized as follows:

1) To propose cost-effective architectures for utilizing bandwidth in WDM optical networks.
2) To devise efficient algorithms for contention reduction in WDM networks under various traffic scenarios.

3) To devise efficient scheduling algorithms for utilization of void intervals as all busts do not arrive continuously.
4) To provide new algorithms for survival OBS networks.

Proposed Methodology:

Burst loss is due to contention the major limitation of OBS. The contention can occur due to unavailability of a wavelength at the desired port for the incoming burst. Several techniques are preferred to avoid contention such as FDLs, deflection Routing, Wavelength Conversion and Segmentation based dropping. FDLs can provide temporary delay by routing a light on the specific FDLs ring [23] but this is not efficient due to bulky FDLs. In Deflection Routing [24] incoming conflicting burst is rescheduled by using another physical path to the same destination. But this technique is not suitable when the network connectivity is very low. In wavelength conversion [25], wavelength converters are used to convert one wavelength to another. When there are two bursts destined for the same output port, the core node assigns a different wavelength to the incoming burst. It would be beneficial approach if the cost of wavelength converters (WCs) would be low but WCs are very expensive devices. Segmentation based dropping [26] is another technique in which only the segment of the incoming burst which overlaps with the existing burst is dropped instead of dropping the whole burst.

In OBS networks, each data burst (DB) is associated with a corresponding Burst Header Packet (BHP) which is sent ahead of the DB on different WDM channel. The BHPs task is to reserve required resources ahead of the burst as well as DBs path information for path configuration. If the scheduling request is rejected at one OBS core node, then there will never be validation of optical path setting-up for the arriving DB. Since, the DB will arrive anyhow to an input port core node which no longer belongs to its corresponding BHP; it will be dropped or reach to unpredictable destination. Hence there is a need of mechanism to schedule these DBs to proper destination node so that OBS can be realized even with nodes employing relatively simple optical switching fabrics with millisecond to microsecond switching speeds.

A scheduling algorithm will process a control packet before the data burst arrives and find a suitable void interval for the burst if there exists. Otherwise, a burst may be discarded either because a reservation cannot be completed before the burst arrives or simply because the scheduling algorithm is inefficient to make the reservation. Hence, an efficient scheduling algorithm which can reduce burst loss and contention by rapidly scheduling bursts in an efficient way must be designed.

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